

RESEARCH NOTE

THE EFFECT OF HABITAT STRUCTURE ON WEB HEIGHT PREFERENCE IN THREE SYMPATRIC WEB-BUILDING SPIDERS (ARANEAE, LINYPHIIDAE)

The quality of a foraging site can have a significant effect on the survival, growth and reproductive success of web-building spiders (Riechert & Tracy 1975; Lubin et al. 1993; Ward & Lubin 1993). Consequently, web-spiders can be expected to be found most often in areas where prey is abundant. Some spiders, such as Linyphiidae or Agelenidae, construct more or less permanent and costly webs (Janetos 1982); and a movement to another web site involves both the desertion of the old web and a high energy investment in web construction at the new site (Janetos 1986). Thus, web site selection is a particularly important issue for these spiders (Janetos 1982).

Several factors may influence web site selection (Colebourn 1974; Uetz et al. 1978; Olive 1980; Brown 1981; Pasquet 1984). For example, spiders may select web sites in order to exploit specific prey types (Cherrett 1964; Uetz et al. 1978; Olive 1980; Ward & Lubin 1993) or to utilize the physical characteristics of a web site (Robinson 1981; Greenstone 1984; Pasquet 1984; Bishop & Connolly 1992; Ehmann 1994).

In the present study, web site selection in terms of web height was investigated for three sympatric linyphiid spiders, by testing whether the presence of a surrounding understory vegetation can influence the web height selected on young conifer trees. The studied spiders, *Frontinellina frutetorum* (C.L. Koch 1834), *Neriene radiata* (Walckenaer 1841) and *Linyphia triangularis* Clerk 1757 construct three-dimensional sheet webs consisting of a centrally located platform with barrier threads above to intercept flying prey, knocking them to the platform where the spiders hang waiting underneath. Voucher specimens of each species were deposited in the Arachnoidea collection, at the Natural History Museum Vienna, Austria.

The study was conducted in a mixed deciduous forest in eastern Austria, near Wörth an der Lafnitz, approximately 15 km from Hartberg (Styria). The study site (total area: 2854 m²) was comprised of plantations of Douglas fir (*Pseudotsuga menziesii*) and most webs were built on the young cultivated fir trees (Herberstein 1997). The study site was subdivided into four plots and fenced in to protect the trees from browsing animals. The fencing allowed a dense understory of grasses, ferns, raspberry and blackberry bushes to grow around the trees, which was cut every fall as part of forestry management.

An initial survey of web height (the distance from the ground to the sheet of the web) in 1993 (Herberstein 1997) suggested that web height was not constant throughout the year but increased as the season progressed. This trend was confirmed in 1994. Ten transects (10 × 1 m) were chosen each month (March–October) by randomly selecting the starting point and the direction (N, E, S, or W) of the transects which were allowed to intercept. Each inhabited web found along the transects was surveyed. There were significant positive correlations between web height (using individual data points) and time of the year for *F. frutetorum* ($r = 0.47$, $n = 152$, $P < 0.01$), *N. radiata* ($r = 0.48$, $n = 224$, $P < 0.01$), and *L. triangularis* ($r = 0.27$, $n = 287$, $P < 0.01$) (Fig. 1).

At the same time as the spiders' web height increased, the vegetation surrounding the fir trees also increased in height, reaching its maximum height (Mean \pm SD = 1.05 \pm 0.33 m) in August/September. The observed change in web height may thus be a response to the growth of the understory, which overgrew web sites closer to the ground and reduced their attractiveness. Consequently, webs on trees lacking a surrounding understory are

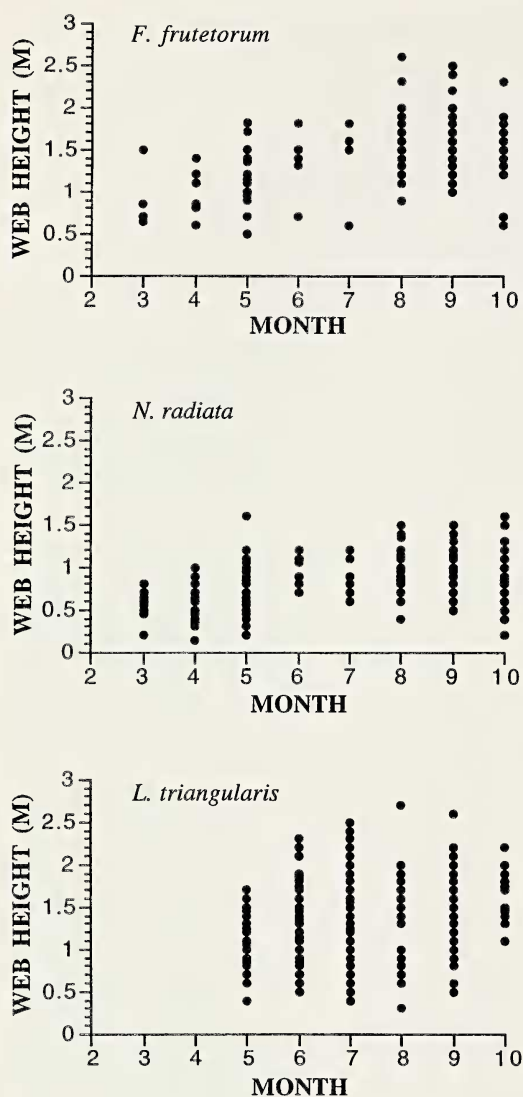


Figure 1.—The web heights are significantly correlated with time of the season for *Frontinellina frutetorum*, *Neriene radiata* and *Linyphia triangularis*.

expected to be placed closer to the ground compared to webs on trees surrounded by an understory. This assumption was tested during an experiment conducted from 10–15 August 1994 and from 2–13 September 1994.

Twenty firs were selected in close proximity (within an area of 20×20 m), depending on the similarity of their height (mean \pm SD = 2.03 ± 0.09 m), to reduce the effect of tree variability and habitat differences on web height selection. The trees were randomly allocated “control” or “experimental” trees.

The vegetation surrounding the 10 experimental trees was cut, leaving a clearance of 1 m in diameter, whereas the remaining 10 control trees were left in their natural condition, with a mature understory (maximum height: 1.2–1.5 m) surrounding them.

Before commencing the experiment, the 20 trees were surveyed twice (in the morning and the afternoon) and any spiders or webs on the trees were removed manually to avoid interference by other spiders, previously present on the trees. As spiders may be attracted to areas where silk is present (which may bias the results) the removal of spiders and web silk was carried out with great caution.

Immature *F. frutetorum* and *N. radiata* and adult *L. triangularis* were collected in the morning and marked on the abdomen with red, nontoxic paint. Twelve hours later, each spider was released onto the lowest branch (0.1–0.2 m from the ground) of each tree. Only a single spider was released per tree. The following morning the web height of each marked spider was measured, and the spiders and webs were removed.

As not all spiders responded by constructing a web, the entire procedure was repeated five times. The data sets were distributed normally (Kolmogorov-Smirnov Goodness of Fit tests) and differences in web height on trees with and without an understory were analyzed using one-tailed *t*-tests. Bonferroni's correction ($\alpha' = \alpha/k$, where k equals the number of non-independent tests) was used to analyze the results ($P = 0.05/3 = 0.017$) in order to avoid inflation of the type I error probability.

Removing the shrub layer had a significant effect on the position of the webs. The web heights of *F. frutetorum* ($t = 2.5$, $df = 56$, $P = 0.0073$), *N. radiata* ($t = 3.05$, $df = 58$, $P = 0.0018$) and *L. triangularis* ($t = 2.5$, $df = 61$, $P = 0.0081$) were significantly higher on trees surrounded by an intact understory than on trees without (Table 1). These results indicate that the vertical movement upwards may be a consequence of growing understory that either physically interferes with the spider webs, or reduces prey abundance to such an extent that the spiders desert their webs.

Spiders may re-locate their webs in response to food supply (Olive 1982; Vollrath 1985; Gillespie & Caraco 1987), disturbance (Hodge 1987b), support structure (Enders 1974; Hodge 1987a; Bradley 1993), variation

Table 1.—The average (mean \pm SD) web heights of *Frontinellina frutetorum*, *Neriere radiata* and *Linyphia triangularis* on trees with understory vegetation and without understory vegetation.

	Web heights (m) on trees	
	Understory intact (n)	Understory removed (n)
<i>Frontinellina frutetorum</i>	1.32 \pm 0.30 (28)	1.10 \pm 0.35 (30)
<i>Neriere radiata</i>	0.79 \pm 0.22 (27)	0.63 \pm 0.21 (33)
<i>Linyphia triangularis</i>	1.52 \pm 0.40 (32)	1.27 \pm 0.38 (31)

in microclimatic conditions (Biere & Uetz 1981) or a combination of these factors. Spiders are unlikely to determine prey availability prior to web construction (Janetos 1986) or to use long term memory of site quality (Vollrath & Houston 1986). Thus, it seems unlikely that the web height selected by the spiders during the experiment is in direct response to prey abundance. Instead, the spiders might use microclimatic cues, which in turn may affect prey abundance.

The results of this experiment demonstrate that web placement in spiders is selective and can be influenced not only by the actual support structure utilized for web placement but also by the surrounding substrate such as a dense undergrowth.

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- Marie Elisabeth Herberstein¹:** Institute of Zoology, University of Vienna, Althanstr. 14, A-1090 Vienna, Austria.
- Manuscript received 19 March 1996, revised 15 July 1996.*
- ¹Current address: Department of Zoology, University of Melbourne, Parkville Victoria 3052, Australia